Crestron Electronics, Inc.

Commercial Lighting DALI® Edition Design Guide

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Introduction

Digital Addressable Lighting Interface (DALI®) systems should be used where ballast level control is required. DALI is ideal for open space commercial environments. When cubicle and workspace layouts change, the lighting can be regrouped and adjusted as needed. Other typical applications include college lecture halls, hospital operating rooms, and corporate conference rooms. DALI provides tremendous flexibility for both retrofit and new installations. When replacing lamps and ballasts on a DALI system, the wiring stays the same and the DIN-DALI-2 readdresses the new ballast with the address and parameters of the original ballast.

Crestron® control systems seamlessly connect with the open DALI protocol by way of the DIN-DALI-2 interface. The DIN-DALI-2 interface can work with any Crestron control system as well as any power supply. Crestron devices such as keypads, thermostats, photo and occupancy sensors, gateways, and other Cresnet® devices can easily communicate with the DALI system.

Commissioning lighting groups, detecting faults, and replacing ballasts is simple when using the powerful Crestron DALI Commissioning Tool. The user can develop interactive floor plans using Smart Graphics™, which provides easier monitoring, management, and control of all the light fixtures within the space.

Crestron delivers the most comprehensive DALI ballast solution with 1-, 2-, and 3-lamp versions available for any application, in any part of the world. Crestron Green Light® DALI ballasts support dimming a wide range of fluorescent lamps from 1 to 100%. DALI ballasts are the most comprehensive ballast solution on the market today. The DALI ballasts drive multiple lamp wattages in one unit, which makes lighting design easier and less expensive.

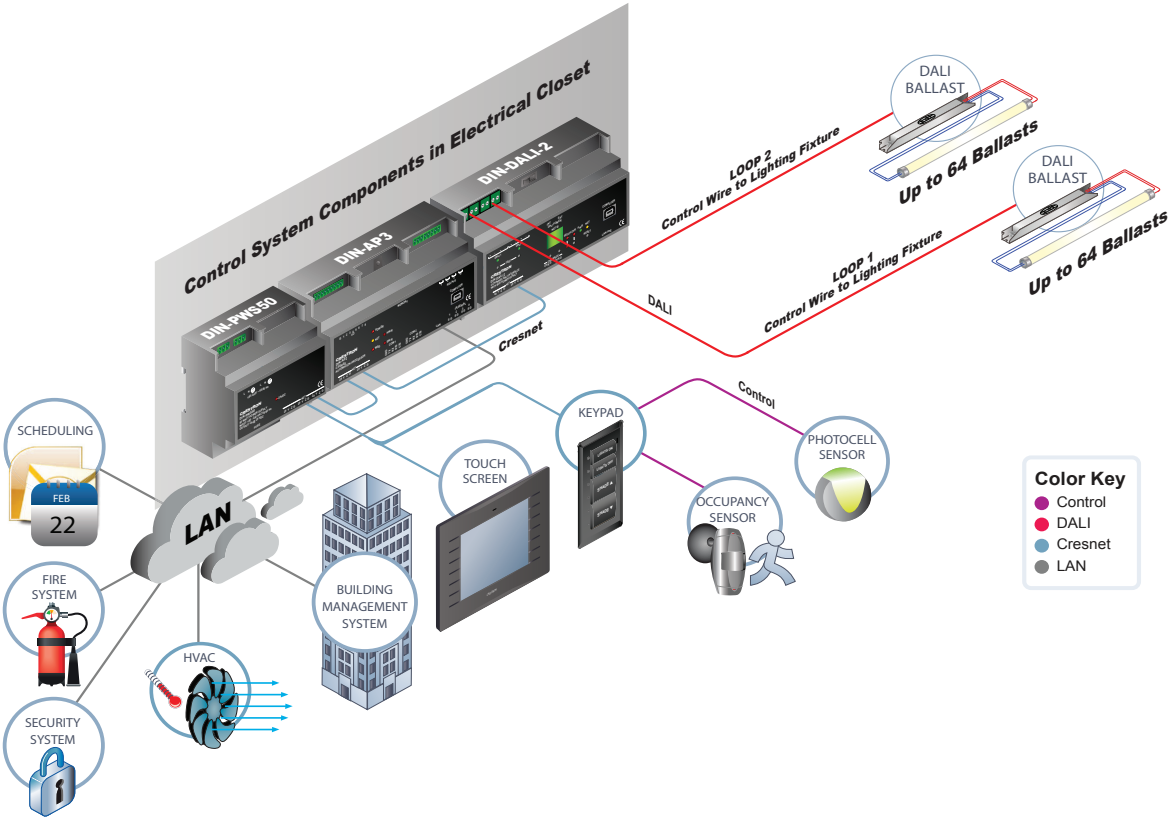
The new line of Crestron dimmable LED drivers provides high-power LED lighting with deep dimming to below 1%. Available in 50 W and 100 W models with DALI control, GLD-LED drivers offer superior, smooth dimming technology using a combination of duty-cycle and current dimming.

The optional built-in power metering feature is unique to Crestron DALI ballasts. The ability to measure, monitor, and manage power to each light fixture, while enabling daylight harvesting and load shedding, makes it easy to implement a fully-integrated system that combines architectural lighting control and energy management all on one platform. Optional power metering models track real-time energy usage of each load and provide essential statistics to help manage and control utility costs.

Refer to the Lighting Control webpage on the Crestron website for more information on DALI ballasts and drivers.

The example below shows how Crestron products communicate with DALI and other building systems.

Communicating with DALI



DALI is a protocol used for the direct control of lighting ballasts. The DALI standard allows multiple ballasts to be daisy-chained using low-voltage wiring for power on/off and dimming control. Up to 64 independently operating ballasts can exist on a single DALI channel. DALI lighting is optimal for applications that require granular control of each fixture, such as open office floor plans and daylight harvesting in classrooms.

Control wires are topology free (up to 64 between each ballast), making wiring simpler than in 0 to 10 V dimming systems. DALI systems can report lamp and ballast failure for easier maintenance and, with Crestron PM ballasts, controllers can query energy usage. Additionally, the DALI data is resistant to noise, which allows it to run alongside line-voltage power lines. The Crestron DALI Commissioning Tool simplifies system installation and provides a setup wizard with step-by-step configuration of ballast properties, groups, and scenes.

Spaces with changing tenants and large campuses with frequently repurposed rooms are the prime target of DALI systems. Some of the key features are as follows:

- **Individual Addresses:** Each DALI ballast has its own unique address on the system; therefore, the system is able to communicate with each ballast independently of the others.
- **Number of Addresses:** Up to 64 addresses can be on one DALI loop. An unlimited number of loops can be placed on a complete DALI networked system.
- **Grouping:** DALI ballasts can be assigned to 1 to 16 groups on a loop, without the need for rewiring.
- **Bi-directional Communication:** Ballasts are able to receive information as well as report lamp or ballast failures to the central DALI system.

- **Readdressing Ballasts:** If a ballast fails on a system, the loop can detect the missing address and readdress it when a new ballast is added back in its place.
- **Warranty and Compliance:** Crestron DALI ballasts include a 5 year warranty. The ballasts are UL® Listed, CE marked, and RoHS Compliant®.

DALI Requirements

The intent of the DALI protocol is to supply low cost, interchangeable ballasts that are simple to program and commission. DALI requirements are shown below:

- **Ballast Power Requirements:** Ballasts must provide universal voltage (115 to 300 V), 50 to 60 Hz, high power factor, low harmonics, and transient surge protection. When the initial voltage is applied, the lamps go to full on or to a preset level.
- **Command Requirements:** Ballasts are able to receive information and report this information back to the central DALI system regarding lamp or ballast failures.
- **Lamp Response Requirements:** DALI protocol requires a precise logarithmic dimming curve of 254 steps (2.8% increase per step) so that all ballasts dim the same: 0 to 100% for incandescent and fluorescent, 3 to 100% for compact fluorescent, and 0 to 100% for LED.
- **Protocol Requirements:** The DALI protocol requirements include the intent and electrical requirements of the protocol, bits and bytes requirements, collision detection, and the type of wire to be used for the DALI system.

Crestron and DALI-AG Working Group

Crestron is a participating member of the DALI-AG Working Group. Participating members are key suppliers of products and technology that comply with DALI and IEC 62386 standards. As a member, Crestron participates in committee proceedings and plays a role in the development of specifications. Members have total access to all DALI specifications, which are critical to the development of products.

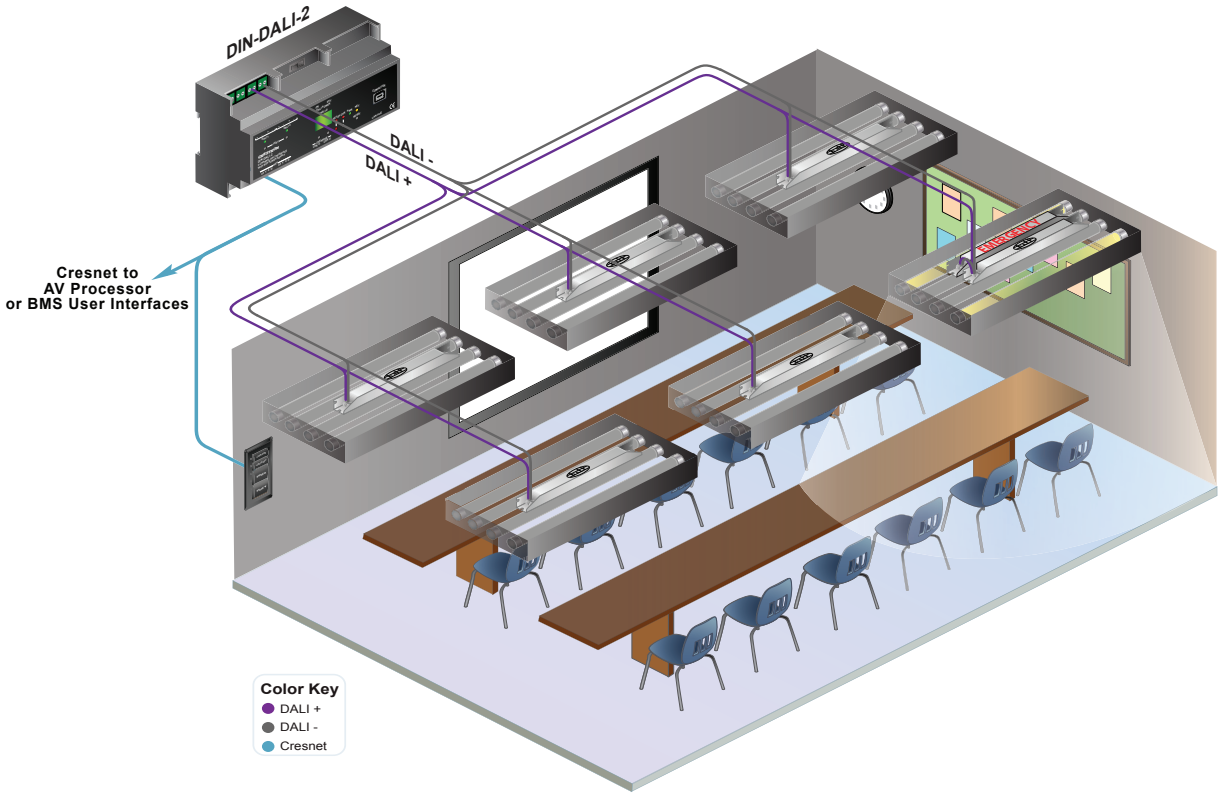
Emergency and DALI Ballasts

Crestron provides cold-start emergency ballasts to illuminate rooms with existing lights during a blackout, eliminating the need for an emergency generator.

The emergency ballast fits into the fixture with the DALI ballast. When a power outage is detected, the emergency ballast lights up one or two lamps in the fixture for more than 90 minutes. This complies with many state and local codes, including the National Electrical Code® and the Life Safety Code® (NFPA 101).

In the example below, five of the six fixtures are without power. One of the fixtures utilizes the emergency backup to illuminate the room. This emergency ballast-powering scenario tremendously reduces wiring costs.

Emergency Ballast-Powering Scenario



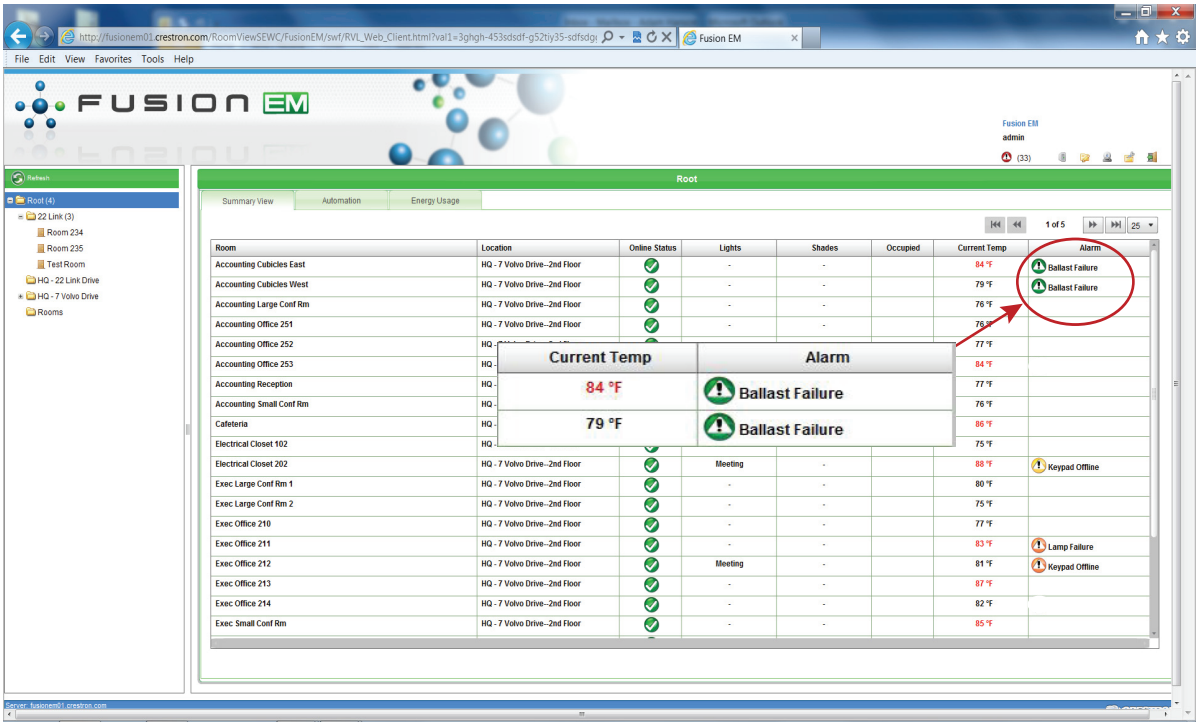
Fusion EM and DALI

Fusion EM® is a simple-to-use web-based energy management interface and facility control solution from Crestron. When utilizing Fusion EM and DALI together, the following can be performed:

- Track the real-time and historical energy usage for a day, week, month, or year.
- View the room statuses for an entire facility.
- Define the settings for occupied and unoccupied states.
- Reduce the energy loads for demand response programs.
- Maintain full control of lighting levels, shades, and climate.
- Interface with a Building Management Systems (BMS) for HVAC control and automation.

The Fusion EM server application allows the user to view both ballast and lamp failures communicated via the open DALI protocol. The example below shows the way in which the Fusion EM application pinpoints a lamp or ballast failure.

Fusion EM Summary View Screen Displaying Ballast Failure



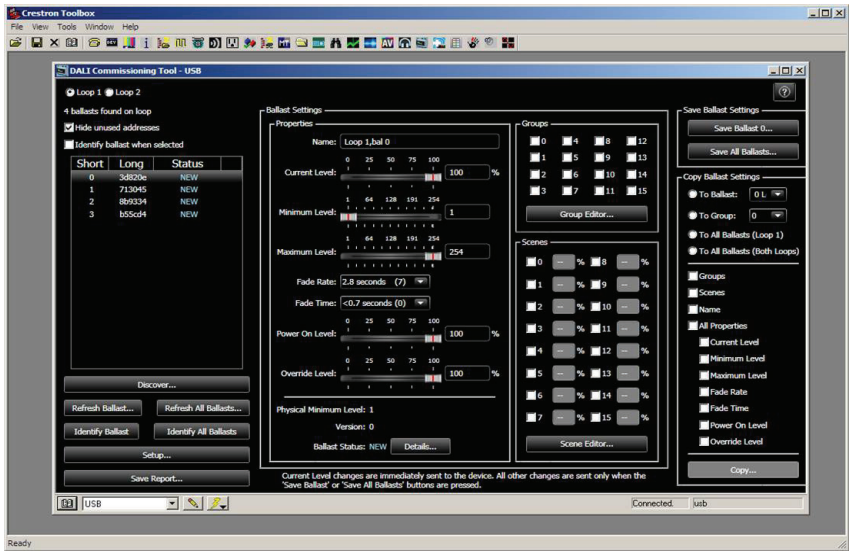
DALI Commissioning Tool

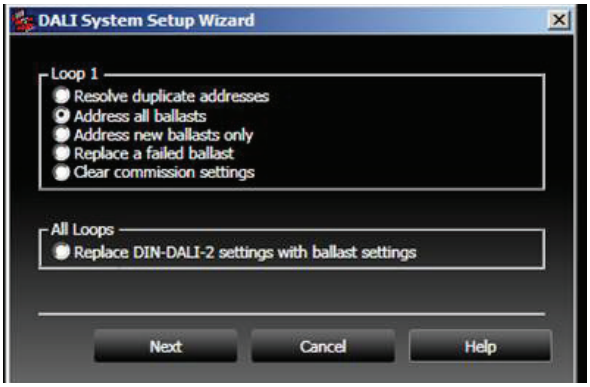
The Crestron DALI Commissioning Tool expedites system installation. The commissioning tool includes a setup wizard that provides step-by-step instructions to configure ballast properties, groups, and scenes. Simply complete the following steps:

1. Set the ballast address.
2. Check the connectivity status.
3. Edit the minimum and maximum levels and fade time.
4. Change the ballast grouping and scenes as needed.

This powerful tool uses automatic identification of new hardware IDs for simple ballast replacement. Settings from old ballasts are transferred to replacements, which saves time and eliminates guesswork.

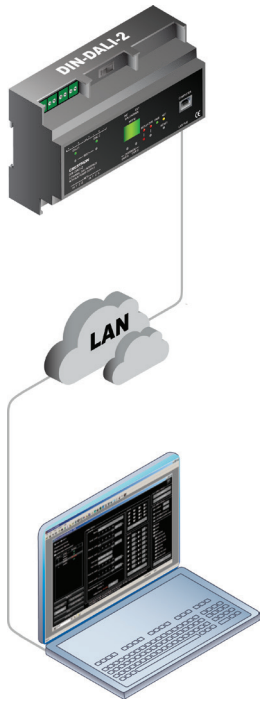
DALI Commissioning Tool Screens



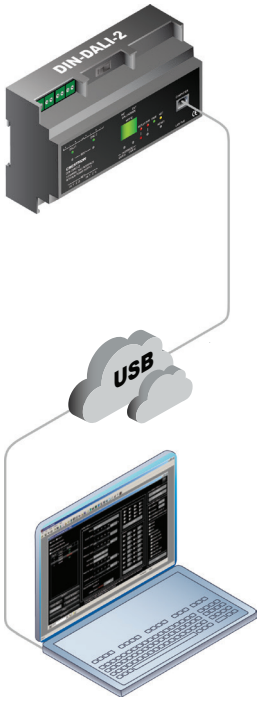


Depending upon the application, there are multiple methods for commissioning a DALI system network. Four methods of connecting to a DIN-DALI-2 are shown below.

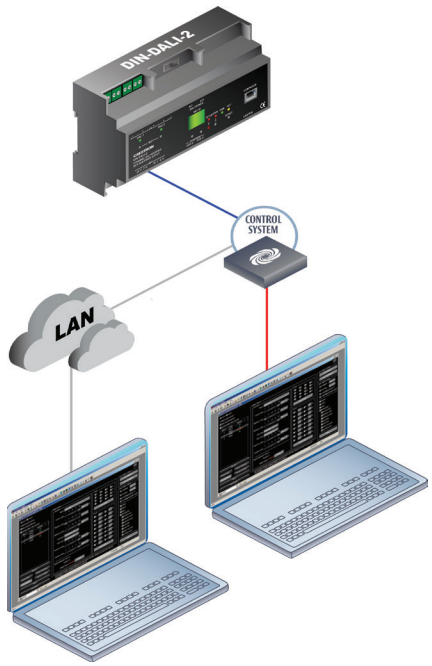
DIN-DALI-2 Over a LAN



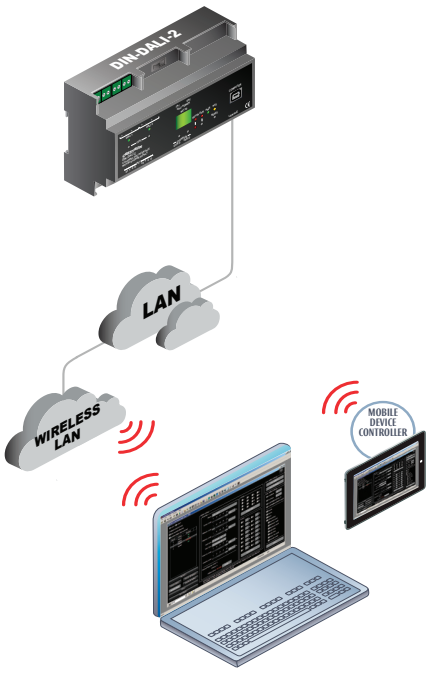
DIN-DALI-2 Direct Connection Over a USB



DIN-DALI-2 Over a LAN Using a Control System



DIN-DALI-2 Over a LAN and Wireless LAN



Crestron DALI Control System Products

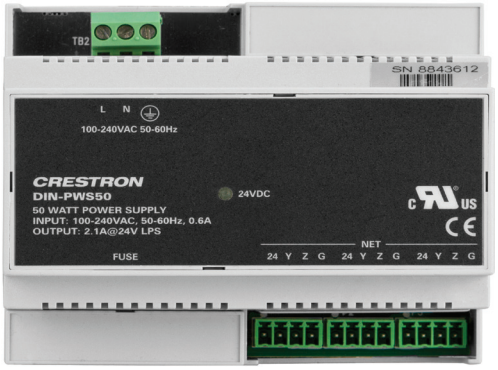
Products that can be used to control a basic DALI control system are shown below.

NOTE: Refer to www.crestron.com for more information on DALI control system products.

DIN-DALI-2: The DIN-DALI-2 is a DALI interface for Crestron systems that provides control for up to two individual DALI loops.

DIN-AP3: The DIN-AP3 is a 3-Series® control processor designed for small- to medium-sized lighting and automation applications.

DIN-PWS50: The DIN-PWS50 is a 50 W Cresnet power supply module designed to snap onto a standard DIN rail for installation in a wall mount enclosure.



DIN-AP3MEX: The DIN-AP3MEX is a 3-Series control processor designed for lighting and automation applications.

In addition to Cresnet connectivity, the DIN-AP3MEX comes equipped with an integrated infiNET EX® wireless gateway for wireless connectivity to a complete Crestron system.

DIN-EN-2X18: The DIN-EN-2X18 is an enclosure that is used for DIN rail devices (two DIN rails and 18 units wide).

DIN-EN-3X18: The DIN-EN-3X18 is an enclosure that is used for DIN rail devices (three DIN rails and 18 units wide).

DIN-EN-6X18: The DIN-EN-6X18 is an enclosure that is used for DIN rail devices (six DIN rails and 18 units wide).

Occupancy Sensors: Crestron sensors deliver a powerful and cost-effective solution for reducing energy and enhancing the functionality of lighting and environmental systems.

The GLS-ODT-C-CN (top left) and GLS-OIR-CSM-EX-BATT (bottom right) models are shown.

Photocell Sensors: Photocell sensors are designed for daylight harvesting applications to provide control of room lighting based on the presence of natural daylight.

The GLS-LCL (top left) and GLS-LOL (bottom right) models are shown.

Keypads: Crestron offers a wide array of elegant designer keypads for home, education, and corporate environments. Keypads provide the user with control of preset lighting scenes and dimming.

The Cameo® keypad models are shown.

Touch Screens: Crestron delivers the maximum value to the customer as the premier source for touch screens. The V-Panel™ 24 in HD Touch Screen is shown.

The V-Panel™ 24 in HD Touch Screen is shown.

DIN-DALI-2 Interface

The DIN-DALI-2 is a DALI interface for Crestron systems that provides control of up to two independent DALI loops. Housed in a DIN rail enclosure, the DIN-DALI-2 is a low-profile Cresnet or Ethernet companion to the DIN-AP3 processor or any 3-Series Control System®. In addition to controlling the DALI data bus, it includes an integrated DALI power supply. The single-wire connectivity simplifies both new and retrofit installations. Power-over-Ethernet (PoE) versatility assists in situations with existing CAT5 infrastructure.

- Controls up to 128 DALI ballasts
- Cresnet or PoE communication for single wire installation
- Crestron DALI Commissioning Tool for easy setup
- Override input for emergency mode
- 9 M wide DIN rail mounting
- CEC Title 24 2013 compliant

For the DALI protocol to communicate with other protocols, a control interface is necessary. The interface acts as a language translator, allowing the DALI protocol to be understood and used by other protocols such as Cresnet, BACnet, and Ethernet. Using the DALI protocol, the primary building systems can easily communicate. The DIN-DALI-2 is powered either through Cresnet or PoE. This simplifies wiring to the DIN-DALI-2 module. All 128 DALI ballasts can be powered in either Cresnet or PoE mode.

DIN-DALI-2

NOTE: Refer to the DIN-DALI-2 product page on the Crestron website for more information.

DALI LED Drivers

Crestron dimmable LED drivers provide high-power LED lighting with deep dimming to below 1%. Available in 50 W and 100 W models with DALI control, GLD-LED drivers offer superior, smooth dimming technology using a combination of duty-cycle and current dimming.

Crestron LED Drivers (GLD-LED) provide manufacturers of dimmable LED lighting fixtures with a high-performance, cost-saving LED driver solution. Offered in two compact case styles, the GLD-LED series fits easily into a wide range of enclosures and fixture designs. All models are operable between 120 V and 277 V, reducing inventory costs for manufacturers serving multiple regions.

Models featuring DALI control are available in either 1- or 2-channel configurations. The 2-channel option provides two independently controllable channels in one housing, offering a cost-saving, space-efficient solution for use with tunable white lighting and fixtures with separate direct and indirect lighting components.

Crestron Green Light Dimmable LED Drivers are programmable using the CREScode™ LED Driver Configuration Tool, allowing each LED driver to be matched perfectly to its fixture at the factory. The configuration tool provides a simple means of selecting the dimming curve and setting the minimum dimming level, NTC temperature, and output current. The output current can be set individually for each LED output. The use of programmable LED drivers reduces inventory requirements, allowing a single driver model to be used with numerous different fixtures.

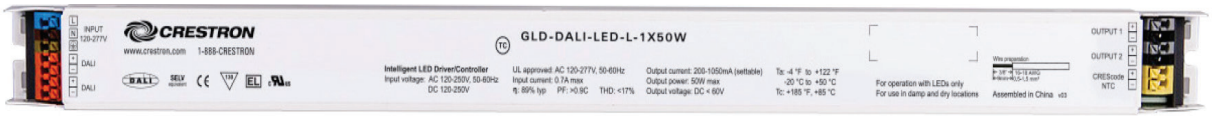
Compatible Dimmable LED Driver Models

The 50 W DALI compatible dimmable LED driver models are the GLD-DALI-LED-L-1X50W, GLD-DALI-LED-S-1X50W, GLD-DALI-LED-L-2X50W, and GLD-DALI-LED-S-2X50W.

The 100 W DALI compatible dimmable LED driver models are the GLD-DALI-LED-L-1X100W, GLD-DALI-LED-S-1X100W, GLD-DALI-LED-L-2X100W, and GLD-DALI-LED-S-2X100W.

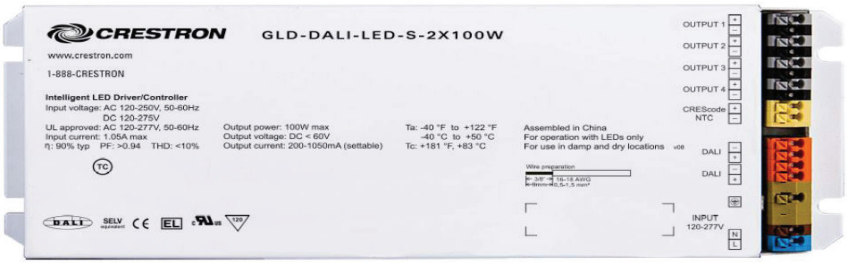
GLD-DALI-LED-S-1X50W

GLD-DALI-LED-L-1X50W

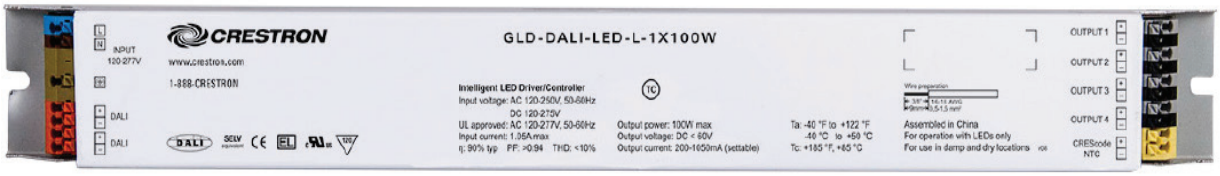


NOTE: Refer to the GLD-LED-50W product page on the Crestron website for more information.

GLD-DALI-LED-S-2X100W



GLD-DALI-LED-L-1X100W



NOTE: Refer to the GLD-LED-100W product page on the Crestron website for more information.

GLDA-LED-PROG-CRESCODE

The CREScode LED Driver Configuration Tool provides a simple means for lighting fixture manufacturers to program Crestron dimmable LED drivers at the factory, allowing the drivers to be matched perfectly to the fixtures in which they are installed. The complete tool consists of a hardware dongle, interface cables, and the software application.

Dongle and Interface Cables

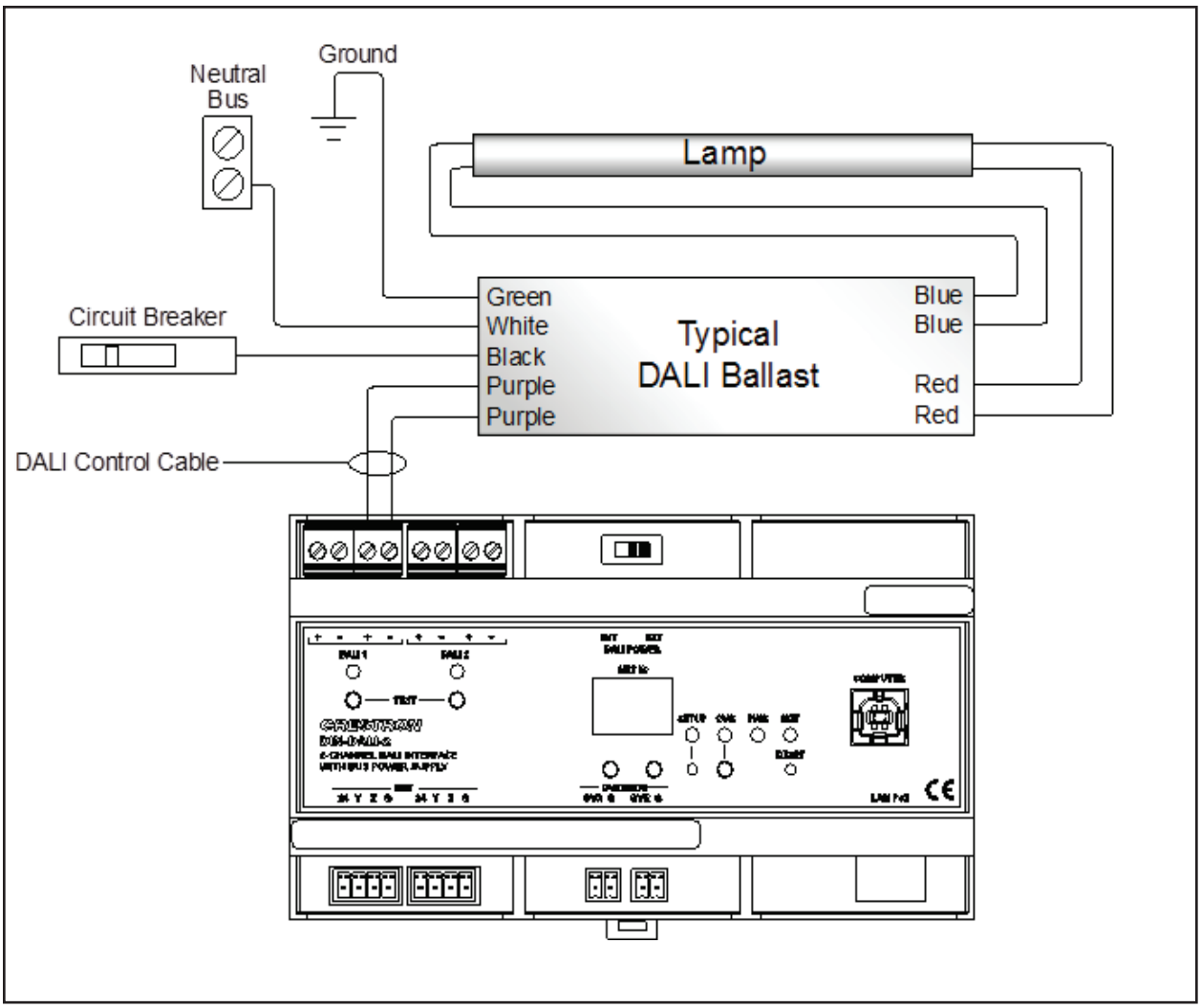
NOTE: Refer to the GLDA-LED-PROG-CRESCODE product page on the Crestron website to download the software application and access instructions on using the CREScode LED Driver Configuration Tool.

NOTE: This tool is not intended for use by lighting installers and is not required for setup of LED drivers in the field.

DALI Control Cable

The DALI standard does not require shielded wire. However, unshielded wire may be subject to induced voltage degradation and interference. Crestron recommends using shielded cable because if unshielded DALI cable is used and improperly installed, signal failures may occur. DALI control wire is sized appropriately based upon voltage drop due to cable length. Crestron recommends 16 to 22 AWG based upon cable length. The DALI protocol standard can communicate up to 980 ft (300 m). Per the NEC, class 1 DALI control cable may be run in the same conduit as line voltage wire.

DALI Control Cable Example



DALI Application Examples

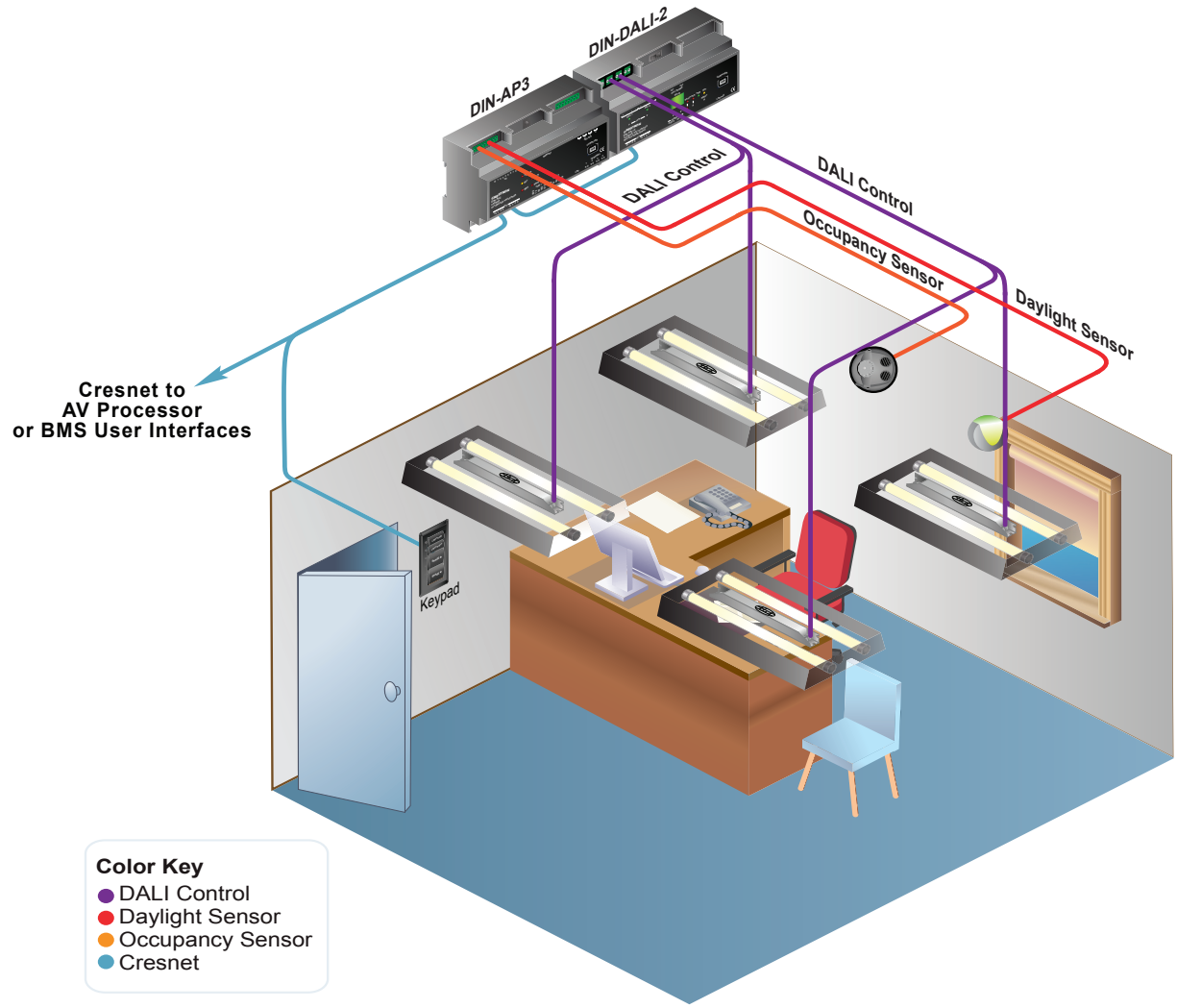
The examples in this section show how a DALI control system can be utilized in an individual office, open office, conference room, and training room.

Individual Office

By controlling the lighting fixtures with the DALI control system, daylight harvesting and room occupancy sensing can be easily achieved by adding sensors.

In the individual office example below, the fixture closer to the window is dimmed lower than the one further from the window based on the amount of natural light. The photo sensor measures the outdoor light while the occupancy sensor determines if the room is in use. The Cameo keypad provides the user with control of preset lighting scenes and dimmer control.

Individual Office Using a DALI Control System

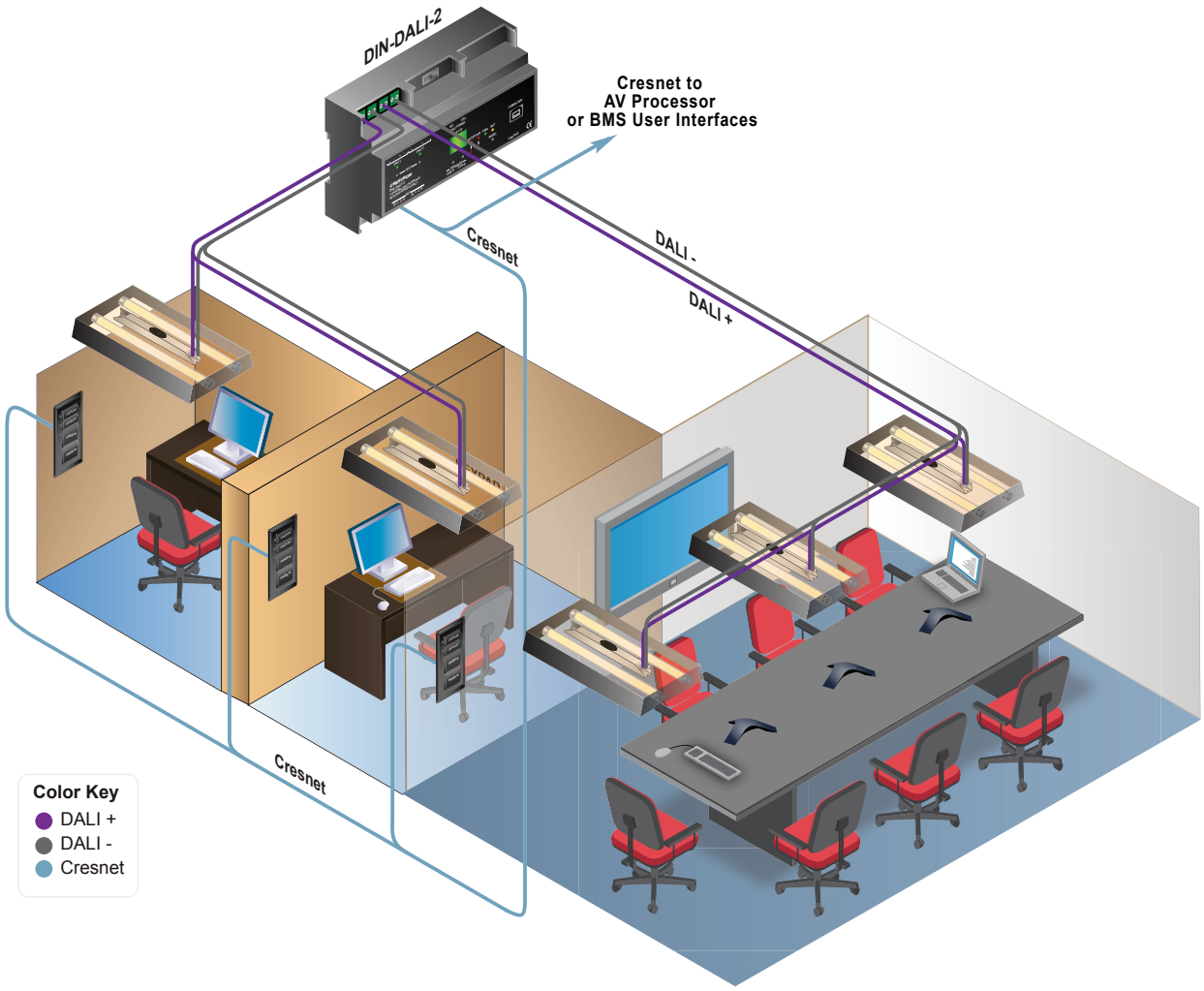


Open Office

When installing a DALI control system in larger office spaces, wiring across multiple units decreases installation time. The ability to move light fixtures around the grid without the need to rerun wire becomes invaluable.

The example below shows how a DALI control system can be utilized within an open office setting.

Open Office Using a DALI Control System

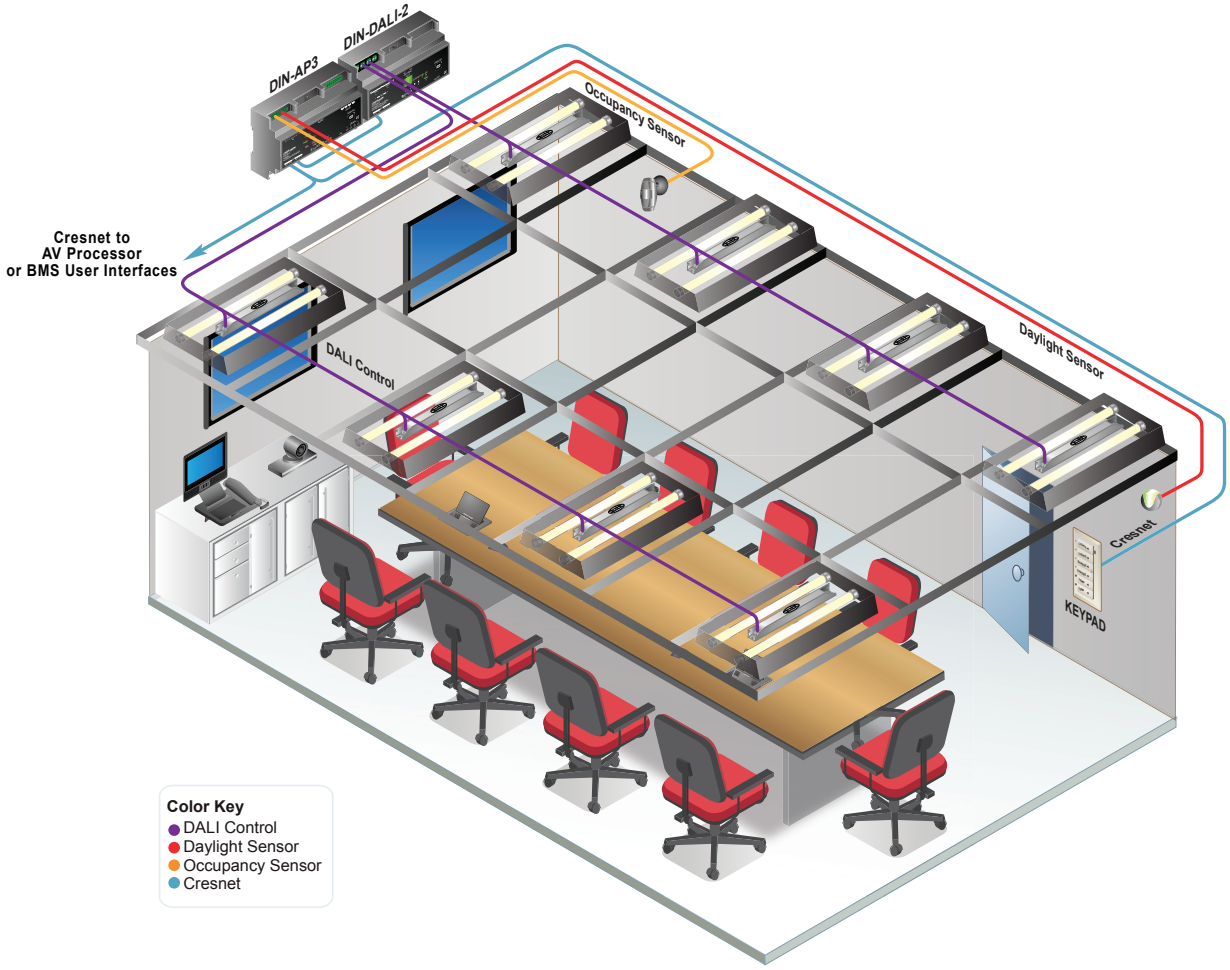


Conference Room

Each light fixture is powered through the DALI control system. A photocell and occupancy sensor are incorporated into the system. A sensor is connected to the nearest available DALI control system and keypad to provide preset lighting scenes and dimmer control.

The example below shows how a DALI control system can be utilized in a conference room setting.

Conference Room Using a DALI Control System

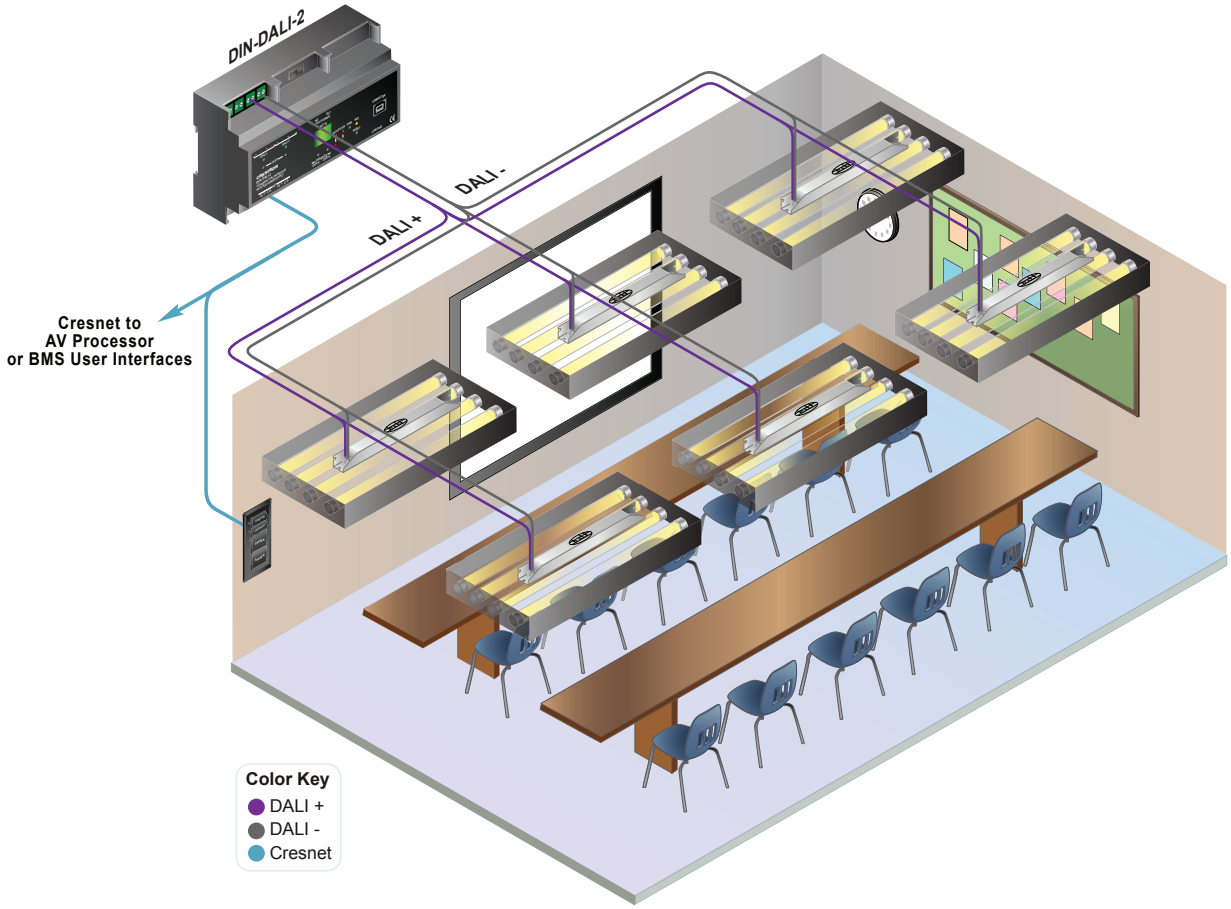


Training Room

Each light fixture is powered directly from the grid with each row of lights controlled by a separate channel on the DALI control system. One channel dims the row closest to the windows while the second channel dims the other row. Both a photocell and occupancy sensor are connected to the DALI control system for energy savings.

The example below shows how a DALI control system can be utilized in a training room setting.

Training Room Using a DALI Control System



Glossary of Terms

Ballast: An electrical device required in fluorescent and high intensity discharge (HID) fixtures that furnish the necessary voltage, current, and waveform for starting and operating the lamp(s). In the United Kingdom, it is sometimes referred to as a choke or control gear.

Current: The electrical rate of flow expressed in amperes—similar to the water flow rate in a pipe (gal/min).

Dimming ballast: A device used to obtain the conditions (voltage, current, and waveform) for starting and operating the lamp(s) while providing variable light output such as dimming fluorescent lamp source(s). It must be matched to the lamp type, voltage, and quantity. It is also available, with less capability, for HID sources.

Emergency lighting: When the normal power supply fails, emergency lighting is the illumination that automatically lights the path towards the exit location(s). It may also serve to satisfy life safety and security lighting requirements.

Fade delay: The time interval between the selection of a new light intensity for a particular lighting zone and the beginning of that zone's change to the new level.

Fade time: The total time it takes a dimmer to change lighting from one level to another.

LED driver: A self-contained power supply that has outputs matched to the electrical characteristics of the LED or array of LEDs.

Line voltage: The standard 120 V power provided by receptacles and for lighting fixtures in commercial spaces; it might refer to 277 V power feed for fluorescent fixtures.

Occupancy sensor: A sensor that works with certain Crestron lighting systems to save energy and increase convenience by automatically turning lights on when a space is occupied and off when a space is vacant.

Photosensor: A control agent for fixtures that can automate light levels. Some photosensors qualify controls for certain rebates and incentives.

Scene: The lighting effect achieved by adjusting one or more zones of lighting to the desired intensity.

Self-ballasted lamps: A fluorescent or discharge lamp that has an integral ballast.

UL Listed: A product adhering to the standards of Underwriters Laboratories, a company nationally recognized for product safety testing.

Voltage: The electrical power, in volts, of pressure supplied by an electrical circuit to a lighting source. Standard US power supply is 120 V 60 cycle (277 V 60 cycles in commercial spaces). Standard international power supply is 220 to 240 V 50 cycles. It is the pressure of the power supply similar to the psi pressure in a pipe.

Watt: The unit of power consumed by any electrical device or lamp (bulb).

Crestron World Headquarters
15 Volvo Drive
Rockleigh, NJ 07647
Tel: 888.CRESTRON
Fax: 201.767.7576
crestron.com

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